Environment and Ecology 43 (2) : 401—407, April—June 2025
Article DOI: https://doi.org/10.60151/envec/SJTN7202
ISSN 0970-0420

Effect of Variable Growing Environment on Performance of Mustard (*Brassica juncea* L.) Varieties under Eastern Plain Zone of Uttar Pradesh, India

Jeetan Raj, A. K. Singh, S. R. Mishra, A. N. Mishra, Shubham Pandey, Kirti Vardhan Pandey, B. Kunal

Received 15 January 2025, Accepted 3 April 2025, Published on 25 April 2025

ABSTRACT

A field experiment was conducted during the *rabi* season of 2022-23 to access the Effect of Microclimate on Growth and Yield of Mustard (*Brassica juncea* L.) in Eastern Plain Zone of Uttar Pradesh, at Agro-meteorological Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya. The experiment was conducted with Split Plot Design (SPD) and comprises three growing environment viz. 31st October (D_1) (22.3°C), 10th November (D_2) (23.5°C) and 20th November (D_3) (18.5°C) and three varieties viz. Kranti (V_1), NDR-8501 (V_2) and Varuna (V_3). Experimental results showed that among three growing environments, the maximum growth and yield recorded on 31st of October (22.3°C) due to favorable weather condition, harnessing of maximum sunshine hours and long crop growing period, followed by the 10th of November (23.5°C) and the 20th of November (18.5°C). Among varieties Varuna had the best varietal performance, followed by NDR-8501 and Kranti varieties. The initial growth and flowering stage of NDR-8501 was much better but at reproductive stage due to high temperature forced maturity reduce the grain yield. This research provides important insights for improving mustard cultivation in comparable Agro-climatic regions, highlighting the significance of accurate agricultural management to achieve optimal yields.

Keywords Microclimate, Split plot design, Growing environment, Varietal performance, Forced maturity.

INTRODUCTION

Rapeseed and mustard are the major *rabi* season oilseed crops of India and stand next to groundnut in the oilseed economy (Gupta and Gupta 2016). It is an important oilseed crop of the family *Brassicaceae* and occupies a prominent place among the leading oilseed crops being next to groundnut both in area and production, meeting the fat requirement of about 50% of the

Jeetan Raj[1]*, A. K. Singh[2], S. R. Mishra[3], A. N. Mishra[4], Shubham Pandey[5], Kirti Vardhan Pandey[6], B. Kunal[7]

[1,5,6]PhD Research Scholar, [2,3]Professor, [4]Assistant Professor
Department of Agricultural Meteorology, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya 224229, India

Email: rajjeetan01062000@gmail.com
*Corresponding author

population in the state of Uttar Pradesh. Farmers are frequently interested in taking mustard in these fields, but research information on this aspect is limited, and it is critical to determine the appropriate mustard genotype and nitrogen requirement, which may prove profitable to the farmer (Raghuvanshi *et al*. 2018).

Mustard is the second most important edible oilseed in India after groundnut, accounting for 27.8% of the Indian oilseed economy. Oilseeds account for 14.1% of the total cropped area in India, with rapeseed-mustard accounting for 3%. India accounts for 28.3% of global acreage and 19.8% of global production, respectively. India produces approximately 6.7 million tonnes of rapeseed-mustard, second only to China (11-12 million tonnes) and the European Union (10-13 million tonnes), and makes a significant contribution to the global rapeseed-mustard industry. It is primarily grown as a catch crop in Punjab, Haryana, Uttar Pradesh, Himachal Pradesh, and Madhya Pradesh (Shekhawat *et al.* 2012).

In several agro climatic areas of Indian mustard is cultivated. It has been discovered that the mustard crop can with stand annual precipitation ranging from 450 to 1150 mm, annual temperatures ranging from 5 to 27°C, and pH ranging from 6.5 to 8.5. Mustard is a C_3 crop, which means it uses the C_3 pathway to absorb carbon. As a result, it has a cost-effective photosynthetic response at temperatures ranging from 15–20°C. Rapeseed and mustard require well-drained, sandy loam soil and a moderate amount of water (240–400 mm). This works well for rain-fed cropping systems (Gupta *et al.* 2023).

MATERIALS AND METHODS

The study was conducted at the Student's Instructional Farm of Acharya Narendra Deva University of Agriculture & Technology, situated in Kumarganj, Ayodhya (UP) during the *kharif* season of 2022. The farm is located along the Faizabad-Raebareli road, approximately 42 kilometers from the district headquarters of Ayodhya. Geographically, it is positioned at a latitude 26°47'North, longitude 82°12' East and altitude with an elevation of 113 meters above sea level. This location is characterized by the Indo-Gangetic alluvial plains of Eastern Uttar Pradesh. The Ayodhya district is in the semi-arid zone, with an annual rainfall of 1067 mm approximately, 85% of total rainfall is received during the South-West monsoon (from June to September), with the remaining 5–7% received during the winter season. During the crop growth period, the average weekly minimum and maximum temperatures ranged from 12.6°C to 31.5°C and 5.0°C to 19.9°C, respectively. The average relative humidity ranged from 52.2% to 94.4%, the soil temperature ranged from 5 cm (10.6°C to 24.1°C), 10 cm (10.6 °C to 24.2°C), and 20 cm (10.5°C to 24.2°C), and bright sunshine ranged from 0.7 to 8.5 hrs. During the crop period, the total rainfall recorded was 5.4 mm. The triangular soil classification method identifies the field soil as silty loam, with low levels of organic carbon, nitrogen, sulfur, and phosphorus, and medium potash content.

The experiment was carried out in SPD (Split Plot Design). Nine treatment combinations comprise of three growing environments viz. crop sown on 31st October (D_1) / (22.3°C), 10th November (D_2) / (23.5°C) and 20th November (D_3) / (18.5°C).

Kept in main plots along with three varieties i.e. Kranti, NDR-8501 and Varuna were kept in sub plots in the investigation. The initial plant population was counted after complete germination at 15 DAS and at crop harvesting time in each individual plot of the experimental field. The height of the mustard plant was measured from base to apex at harvest using a meter scale. The average height was calculated by summing the heights of five randomly selected plants per plot and dividing by five. Counts of primary and secondary branches were recorded from five specimens, and mean values were determined. Five border row plants were sun-dried and then oven-dried at 65°C ±1 until constant weight for dry matter estimation (g plant^{-1}). Leaf samples from five plants were collected at 90 days after sowing (DAS), and leaf area was measured with a leaf area meter.

$$LAI = \frac{\text{Leaf area}}{\text{Ground area}}$$

The number of primary and secondary branches per plant was measured on five randomly selected plants at 60, 90 days after sowing (DAS) and at harvest, with mean values calculated. Similarly, five plants from the border rows were chosen at 30, 60, 90 DAS, and at harvest. After sun drying, the samples were oven-dried at 65±1°C until constant weight, and the average was recorded as dry matter (g plant^{-1}). Stover yield was calculated by subtracting seed yield from total produce on a net plot basis. Stover yield was measured in kg plot^{-1} area and converted to qha^{-1}.

Yield attributes parameters

Number of siliqua per plant

The total number of siliqua of sample plants from each plot was counted at harvest, and their mean value was calculated. The number of siliqua on primary, secondary, and tertiary branches was counted separately. The total number of siliqua plant^{-1} was calculated by adding the number of siliqua on each type of branch.

Length of siliqua (cm)

Ten siliqua were chosen at random from each plot, and their length was measured from the base to the tip, and a mean value was calculated.

Number of seeds per siliqua

At harvest, seeds siliqua^{-1} were counted by counting the number of seeds from ten randomly selected siliqua.

1000 seed weight (g)

Counting of 1000 seeds was done on seed counter from the sample of each plots produced and the weight of counted seeds were recorded with the help of electronic balance. It was recorded for all the plots separately and average was drawn.

Yield parameters

Grain yield (q/ha)

The net plot area was harvested from the individual plots, and the produce was sun dried. The crop was threshed and cleaned separately on a net plot basis after sun drying. The final weight was calculated in kg plot^{-1} and then converted to qha^{-1}.

Stover yield (q/ha)

Biological yield (q/ha)

Above the ground parts of plant was harvested per plot after maturity them weighted to represent the biological yield and expressed in q/ha.

Harvest index (%)

The harvest index is the ratio of grain yield and biological yield, it was calculated by formula given by Donald and Hamblin (1976) :

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Meteorological and micrometeorological parameters

Maximum, minimum temperatures, maximum and minimum relative humidity, bright sunshine hours, soil temperatures at various depth, evaporation, wind speed and rainfall were collected from the Agro- meteorological observatory situated in the same farm during crop growing period on daily basis.

Maximum temperature (°C) above crop canopy

The maximum temperature was recorded during the last 24 hour in °C with Infrared Thermometer (FLUKE-574) at 1400IST. The Thermometer was held at 45°C to the horizontal plane above the canopy in a downward direction towards the crop surface.

Minimum temperature (°C) below crop canopy

The minimum temperature was recorded during the last 24 hour in °C with Infrared Thermometer (FLUKE-574) at 0700IST. Generally, it occurs just before the sunrise, early in the morning.

Relative humidity (%) above and below crop canopy

The ratio of the amount of water vapor required for saturation at a given temperature and pressure is known as relative humidity. It is possible to express it as a percentage or a ratio.

$$\text{Relative humidity (\%)} = \frac{\text{Water vapor present in air}}{\text{Water vapor required for saturation}} \times 100$$

Rainfall (mm)

Rainfall was recorded during the crop growing period in mm from Agro-meteorological observatory of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya.

RESULTS AND DISCUSSION

Leaf area index (LAI)

Leaf area index of mustard as affected by growing environments and varieties recorded at successive growth stages and observed gradual increase up to 60 DAS before declining (Table 1). The data clearly show that the LAI was significantly affected by different growing environments at all stages. Planting date of 31st October, showed significantly higher LAI, while the growing environments of 20th November showed the lowest LAI at all crop stages. These findings are in agreement with Bhuiyan *et al.* (2008), Kumari and Singh (2012) and Singh *et al.* (2019).

The varieties had no effect on the leaf area index at 30 DAS but did have an effect at 60 and 90 DAS. The Varuna varieties had the highest leaf area index (4.5) at 90 DAS while NDR-8501 had the lowest leaf area index (4.1) across all growth stages. The results are in conformity with Naragund *et al.* (2023).

Dry matter accumulation (g/m²)

Dry matter accumulation observed significantly higher under the treatment when mustard was grown on 31st October, compared to the other two growing environments (Fig. 1). At all stages, late-sown mustard had the lowest dry matter. The results are in conformity with the Sahu *et al.* (2019) and Lallu and Srivastava (2010).

Varuna varieties had higher dry matter accumulation, which was comparable to NDR-8501, whereas

Table 1. Leaf area index of mustard as affected of growing environments and varieties.

Treatments	Leaf area index 30 DAS	60 DAS	90 DAS
	Growing environment (3)		
31st Oct (D_1) (22.3°C)	1.5	4.5	4.5
10th Nov (D_2) (23.5°C)	1.5	4.3	4.4
20th Nov (D_3) (18.5°C)	1.4	2.8	4.1
SEm±	0.04	0.07	0.09
CD at 5%	NS	0.26	0.32
	Varieties (3)		
Kranti (V_1)	1.5	4.2	4.2
NDR-8501 (V_2)	1.4	4.2	4.1
Varuna (V_3)	1.5	4.4	4.5
SEm±	0.02	0.07	0.09
CD at 5%	NS	0.20	0.27

Kranti varieties had the lowest dry matter accumulation at all growth stages. The results are in conformity with the Singh *et al*. (2019) and Kumar *et al.* (2024).

Number of branches per plant

During all growth stages, the maximum number of primary branches per plant (20.1) was observed with the first growing environments on 31st October, which was significantly higher than the second growing environments on 10th November (19.1) and the third growing environments on 20th November (16.9) (Table 2). The results are in conformity with the earlier findings of Tripathi *et al*. (2021) and Singh

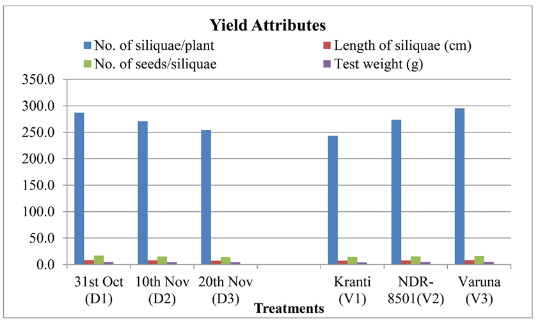

Fig. 1. Yield attributes of mustard cultivars influenced by different growing environments.

Table 2. Number of branches per plant of mustard as affected by growing environments and varieties.

Treatments	Number branches per plant
Growing environment	
31st Oct (D_1) (22.3°C)	20.1
10th Nov (D_2) (23.5°C)	19.1
20th Nov (D_3) (18.5°C)	16.9
SEm±	0.28
CD at 5%	0.98
Varieties	
Kranti (V_1)	15.3
NDR-8501 (V_2)	19.8
Varuna (V_3)	21.1
SEm±	0.35
CD at 5%	1.04

et al. (2019).

The number of branches per plant varies greatly depending on the variety. Varuna had the most (21.1) followed by NDR-8501 (19.8) and Kranti (15.3). These findings are in agreement with Singh *et al.* (2019).

Yield attributing characters

Number of siliquae per plant

A review of the data revealed that the number of siliquae per plant had a significant influence on different growing environments (Table 3). The crop with growing environments from the 31st October had the significantly higher number of siliquae per plant (287.0) than from the 10th and 20th November environment.

Varuna varieties produced the most siliquae per plant (295.4), followed by NDR-8501 (273.7) and Kranti (243.39). These findings are in agreement with Kumar *et al.* (2016) and Singh *et al.* (2019).

Length of siliqua (cm)

The maximum length of siliqua (8.2) was recorded when the crop was grown on October 31st, which was significantly superior to the growing environments on November 10th and November 20th (Table 3). On the 20th November, the shortest length of siliqua was measured. Different varieties had a significant impact on siliquae length. Varuna varieties produced the longest siliqua (8.4), followed by NDR-8501 (7.8) and Kranti (7.1). These findings are in agreement with Kumar *et al.* (2016).

Table 3. Yield attributes of mustard affected by growing environments and varieties.

Treatments	No. of siliquae/ plant	Length of siliqua (cm)	No. of seeds/ siliqua	Test weight (g)
Growing environments				
31st Oct (D_1) (22.3°C)	287.0	8.2	17.0	4.6
10th Nov (D_2) (23.5°C)	271.1	7.9	15.1	4.6
20th Nov (D_3) (18.5°C)	254.4	7.2	14.0	4.4
SEm±	5.67	0.12	0.23	0.11
CD at 5%	20.0	0.43	0.79	NS
Varieties				
Kranti (V_1)	243.4	7.1	14.3	4.0
NDR-8501 (V_2)	273.7	7.8	15.6	4.6
Varuna (V_3)	295.4	8.4	16.2	4.9
SEm±	4.28	0.13	0.29	0.01
CD at 5%	12.66	0.39	0.86	0.30

Number of seeds per siliqua

The maximum number of seeds per siliqua (17.0) was recorded when the crop was growing environments on 31st October, which was significantly higher than the 10th and 20th November grown environments (Table 3). When sowing was done on November 20th, the minimum number of seeds per siliqua (14.0) was recorded.

Varuna varieties produced the most seeds per siliqua (16.2), followed by NDR-8501 (15.6) and Kranti (14.3). Similar results are reported by Kumar *et al.* (2024) and Singh *et al.* (2019).

Test weight (g)

A review of the data revealed that different growing environments had no significant effect on the test weight. Maximum test weight (4.6) was recorded

Table 4. Yield of mustard as affected by growing environment and varieties.

Treatments	Grain yield (q/ha)	Stover yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
Growing environment (3)				
31st Oct (D_1) (22.3°C)	20.6	71.1	91.8	22.3
10th Nov (D_2) (23.5°C)	19.2	67.2	86.7	22.4
20th Nov (D_3) (18.5°C)	16.2	58.6	74.8	21.8
SEm±	0.23	1.06	1.91	0.20
CD at 5%	0.82	3.75	6.72	NS
Varieties (3)				
Kranti (V_1)	17.7	51.7	71.6	21.9
NDR-8501 (V_2)	19.7	72.6	88.8	22.1
Varuna (V_3)	20.6	72.6	92.9	22.5
SEm±	0.34	1.10	1.34	0.38
CD at 5%	1.03	3.30	4.02	NS

when crop was grown on 31st October, which was significantly better than the 10th and 20th November growing environments (Table 3). Varuna varieties had the highest test weight (4.9), followed by NDR-8501 (4.6) and Kranti (4.0). Similar results are reported by Kumar *et al.* (2024).

Yield

Grain yield (q/ha)

Maximum grain yield (20.6 q/ha) was recorded when the crop was growing environments on October 31st, which was significantly higher than the yields recorded on November 10th and 20th (Table 4). When the crop was growing environments on November 20th, the minimum grain yield (16.2 q/ha) was recorded. Similar results were reported by Lallu and Srivastava (2010), Kumari and Singh (2012).

Varuna varieties produced the highest seed yield (20.6 q/ha), followed by NDR-8501 (19.7 q/ha) and Kranti (17.7 q/ha) as shown in Fig. 2. Similar results were reported by Singh *et al.* (2019).

Stover yield (q/ha)

A review of the data revealed that the growing environments had a significant impact on the stover yield.

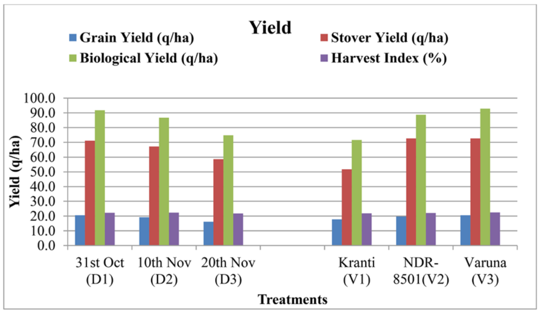

Fig. 2. Yield of mustard cultivars influenced by different growing environments.

Maximum stover yield (71.1 q/ha) was recorded when crop was growing environments on October 31st, which was significantly higher than the 10th and 20th November growing environments (Table 4). When growing environments was completed on November 20th, the minimum Stover yield (58.6 q/ha) was recorded. The results are in agreement with Sharma and Kumar (2023).

As shown in Fig. 2, NDR-8505 had the highest yield (72.6 q/ha), followed by Varuna (72.6 q/ha) and Kranti (51.7 q/ha). Similar results were reported by Kumar *et al.* (2016) and Singh *et al.* (2019).

Biological yield (q/ha)

A review of the data revealed that the maximum biological yield (91.8 q/ha) was recorded when the crop was growing environments on October 31st, which was significantly better than the 10th and 20th November growing environments (Table 4). When growing environments was completed on November 20th, the minimum biological yield (74.8 q/ha) was recorded.

The Varuna varieties produced the highest biological yield (92.9 q/ha), followed by NDR-8501 (88.8 q/ha) and Kranti (71.6 q/ha) (Fig. 2). The results obtained were found in close accordance with Puppala *et al.* (2021) and Meena *et al.* (2021). Significant effect of all treatments on the biological yield of mustard was also observed.

Harvest index (%)

Harvest index (%) data as affected by growing environments and varieties are presented in Table 4. A review of the data revealed that maximum Harvest index (22.4%) was recorded when crop was growing environments on November 10th, which was significantly better than the 31st October and 20th November growing environments. When growing environments was completed on November 20th, the minimum Harvest index (21.8%) was recorded.

Varuna varieties had the highest harvest index (22.5%), followed by NDR-8501 (22.1%) and Kranti (21.9%) (Fig. 2). Similar results were reported by Singh *et al.* (2019).

CONCLUSION

Thus, it may be concluded that crop growing environment of 31st October (22.3°C) gain maximum plant height at all growth stages except 30 DAS, produced significantly higher leaf area index. Dry matter accumulation, number of siliqua/plant, maximum length of siliqua, number of seeds/siliqua and maximum grain yield followed 10th of November (23.5°C) and the 20th of November (18.5°C) while in case of varietal performance Varuna variety had the best, followed by NDR-8501 and Kranti.

REFERENCES

Bhuiyan, M. S., Mondol, M. R. I., Rahaman, M. A., Alam, M. S., & Faisal, A. H. M. A. (2008). Yield and yield attributes of rapeseed as influenced by date of planting. *Journal of Sustainable Crop Production,* 3, 25—29.

Donald, C. M., & Hamblin, J. (1976). The Biological Yield and Harvest Index of Cereals as Agronomic and Plant Breeding Criteria. *Advances in Agronomy*, 28, 361—405.

Gupta, R. D., & Gupta, S. K. (2016). Strategies for increasing the production of oilseed on a sustainable basis. In Breeding Oilseed Crops for Sustainable Production. Academic Press, pp, 1—18.

Gupta, S., Mishra, S. R., Singh, A. K., Mishra, A. N., Agrahari, R. K., & Pandey, A. (2023). Effect of ambient temperature on growth and yield of mustard (*Brassica juncea* L.) cultivars. *Environment and Ecology,* 41 (2A), 1077—1081.

Kumari, A., & Singh, R. P. (2012). Productivity, nutrient uptake and economics of mustard hybrid (*Brassica juncea*) under different planting time and row spacing. *Indian Journal of Agronomy,* 57 (1), 61—67.

Kumar, P., Singh, R. V., Kaushik, S., Kumar, P., Kumar, A., Yadav, V., & Qidwai, S. (2024). Effect of Sowing Dates on Performance of Different Mustard Varieties (*Brassica juncea* L.) in Western Uttar Pradesh, India. *International Journal of Plant & Soil Science*, 36 (6), 91—98.

Kumar, Y., Singh, R., Singh, D., Kumar, A., & Dhaka, A. K. (2016). Influence of Weather Parameters on Yield and Yield Attributes of Mustard (*Brassica juncea*) at Hisar Condition. *Environment & Ecology,* 35 (2C), 1274—1280.

Lallu, Baghel, R. S., & Srivastava, S. B. L. (2010). Assessment of mustard genotypes thermo tolerence at seed development stage. *Indian Journal Plant Physiology,* 15 (1), 36—43.

Meena, V. S., Meena, M. K., Meena, M. D., Jat, R. S., Choudhary, R. L., Singh, H., & Dotaniya, M. L. (2021). Improvement in growth and yield of Indian mustard by using micro and secondary nutrients fortified FYM in calcareous soil, pp 38—43.

Naragund, R., Patel, R. A., Singh, Y. V., Kadam, P., & BR, P. (2023). Effect of irrigation scheduling and nitrogen management on growth and development of Indian mustard (*Brassica juncea*). *The Indian Journal of Agricultural Sciences*, 93 (11), 1231—1237.

Puppala, S., Akula, D. K., & Jaya, T. S. (2021). Variation in dry matter accumulation and growth indices of mustard as influenced by irrigation regimes and fertilizer levels. *Pharma Innovation Journal*, 10 (7), 838—841.

Raghuvanshi, N., Kumar, V., & Dev, J. (2018). Effect of nitrogen levels on mustard (*Brassica juncea* (L.) Cuzern and Coss.) Varieties under late sown condition. *Current Journal of Applied Science and Technology,* 30 (2), 1— 8.

Sahu, J. K., Graham, A., Sahu, Y. K., & Sahu, D. P. (2019). Effect on different date of sowing and yield of mustard crop (*Brassica juncea* L.) under climatic condition Allahabad. *International Journal of Chemical Studies,* 7 (1), 887—888.

Sharma, S. K., & Kumar, A. (2023). Effect of date of sowing on growth, seed yield and economics of Indian mustard (*Brassica juncea* L.) Varieties under rainfed conditions. *Indian Journal Agricultural Research,* 57 (1), 56—59.

Shekhawat, K., Rathore, S. S., Premi, O. P., Kandpal, B. K., & Chauhan, J. S. (2012). Advances in agronomic management of Indian mustard (*Brassica juncea* (L.) Czernj. Cosson): An overview. *International Journal of Agronomy*.

Singh, G., Mishra, A. N., Singh, A. K., Mishra, S. R., Kumar, R., & Kumar, M. (2019). Effect of accumulated heat unit, heat use efficiency and solar radiation interception on mustard cultivars under different growing environment (*Brassica juncea* L.). *International Journal of Chemical Studies,* 7(4), 1703—1705.

Tripathi, K. B. M., Gaur, T., Pandey, L., Singh, A., Tiwari, A.,Prakash, V., & Singh, R. K. (2021). Effect of sowing dates on growth and yield of Indian mustard (*Brassica juncea* L.). *International Journal of Current Microbiology and Applied Sciences*, 10 (01), 3046—3057.